SOME NEW PERMIAN INSECTS FROM BELMONT, N.S.W., IN THE COLLECTION OF MR. JOHN MITCHELL.

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(Plates xxxiii.-xxxiv. and six Text-figures.)

[Read 28th June, 1922.]

In a previous paper (These Proceedings, xlii., pt. 4, 1917, pp. 729-741) I described the first insects discovered by Mr. Mitchell in the Upper Permian Insect Beds of Belmont, consisting of a single genus and species belonging to the new family Permofulgoridae, of the Order Homoptera, and one genus and two species belonging to the new family Permochoristidae, of the Order Mecoptera. In another paper (These Proceedings, xliv., pt. 2, 1919, pp. 231-256) I also described a remarkable wing, also discovered at Belmont by Mr. Mitchell, which forms the type of a new Order Paramecoptera, ancestral to the Trichoptera and Lepidoptera; this insect was named *Belmontia mitchelli*. Since that time, Mr. Mitchell has visited Belmont on a number of occasions, and has recently been accompanied by his friends Mr. and Mrs. T. H. Pincombe of New Lambton. The result of these excursions has been that a considerable area of the strata around the original finds has been thoroughly investigated, and a number of insect wings have been unearthed. The present paper deals with those added to Mr. Mitchell's Collection prior to my recent visit to Belmont in November, 1921. Further finds made during and since that visit will be dealt with in a later paper.

An analysis of the Insect Fauna of Belmont can now be made, on a basis of some twenty wings discovered to date. This shows that the dominant insect type there was undoubtedly a family of Scorpion-flies, the Permochoristidae, which are very closely allied to our existing Australian Scorpion-flies of the family Choristidae, and especially to the genus *Taeniochorista* E.-P., which is to be found around the shores of Lake Macquarie at the present day. Nearly one-half of the specimens of insect wings unearthed at Belmont to date consists of examples belonging to this family. In association with these are two other Mecopteroid types, viz. *Belmontia* Till., placed in the Order Paramecoptera, and

a very interesting new type, described in this paper, which stands in the same relation to the Order Diptera that *Belmontia* does to the Trichoptera and Lepidoptera. In addition to these Mecopteroid types, we are now able to record the first discovery of a true Lacewing (Order Neuroptera Planipennia) of Palaeozoic times; this also is dealt with in this paper. The remainder of the fauna consists of Homoptera, both divisions of that Order being represented at Belmont, the Auchenorrhyncha by the Permofulgoridae and Scytinopteridae (the latter not dealt with in this paper) and the Sternorrhyncha by a perfect wing found by Mr. Pincombe, and here dedicated to its discoverer.

With the exception of a fragment of a large Mecopteroid wing, described in this paper, all the insects so far found at Belmont are of small to medium size, and indicate by far the most highly specialized fauna so far found in any Palaeozoic strata. It would appear to have been a fauna developed in association with the fern *Glossopteris*, in which primitive Scorpion-flies took the place of the Cockroaches dominant in the Carboniferous and Permian beds of the Northern Hemisphere, and Plant-hoppers sucked the juices of the fern-stems. As in the case of the present-day Choristidae, the larvae of the Scorpion-flies probably fed omnivorously on the moist débris scattered on the ground. The discovery of a lacewing of very primitive type shows that the Homoptera already had their enemies; for the larvae of the more primitive Planipennia still feed chiefly on the young of that Order.

The earliest records of insects occurring in Australia are those from the Upper Permian of Newcastle and Belmont. This enables us to draw the striking conclusions that Australia became populated with insects long after the Northern Hemisphere, and that the first insect immigrants were not by any means primitive types by comparison, but representatives of the two most highly specialised divisions of the Pterygota yet evolved, viz. the Hemipteroidea and the Holometabola. From this we may conclude that Australia lay far away from the region of the earth in which insects first became evolved. From what direction the first insect colonists came it is not possible to say with certainty; but it seems reasonable to assume that they were an offshoot of the Gondwanaland fauna, and came in with the associated *Glossopteris*-flora.

I should like to express my grateful thanks to Mr. Mitchell for the opportunity of studying and describing these fine fossils, and my admiration of the keenness and energy which still actuates him, at his advanced age, in carrying on the heavy work necessary in the search for them. I also desire to thank Mr. W. C. Davies, Curator of the Cawthron Institute, for the fine photographs from which Plates xxxiii.-xxxiv. have been prepared.

Order **HOMOPTERA.**

Division *AUCHENORRHYNCHA.*

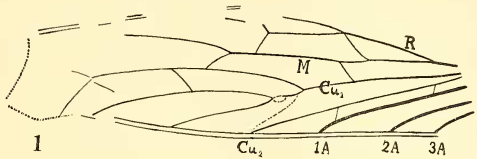
Family PERMOFULGORIDAE.

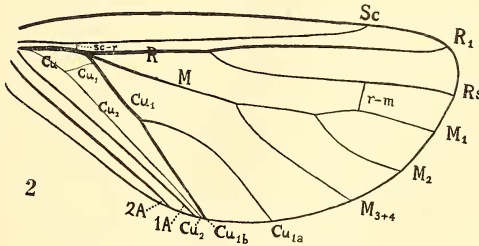
PERMOFULGOR INDISTINCTUS, n.sp. (Text-fig. 1.)

A fragment of a forewing, *total length* 11.5 mm., *greatest breadth* 3.1 mm. The impression is a very faint one, on pale grey cherty shale. All the veins are very indistinct, except only the vena dividens and the three anal veins; these latter are very strongly marked. The species differs from the genotype, *P. belmontensis* Till. in the following points:—Wing narrower, apparently somewhat pointed, though the apex is missing. Only two cubito-anal cross-veins, instead of four. Cu1 with three main branches, and with a very weak oblique

branch or cross-vein descending from near the first dichotomy to the apex of Cu_2; in *P. belmontensis* this branch appears as a definite oblique cross-vein leaving Cu_1 considerably distad from the first dichotomy, and reaching Cu_2 well before its apex; the second dichotomy of Cu_1 occurs much closer to the first in the new species than it does in *P. belmontensis*. M appears to be definitely fused basally with R, and the arrangement of the cross-veins between R, M and Cu_1 shows considerable differences from the condition seen in *P. belmontensis*.

In comparing the new species with *P. belmontensis* (*op. cit.*, p. 730 and Text-fig. 3), it is necessary to point out that, in my former paper, I had considered the vena dividens to be 1A, and consequently assumed 3A to be two-branched. This was an error, and the description and Text-fig. of my former paper need to be altered so that the vena dividens becomes Cu_2, as in all Homoptera, the three anal or claval veins becoming 1A, 2A and 3A respectively.





Text-fig. 1. *Permofulgor indistinctus*, n.sp. (x 8.6).
Text-fig. 2. *Pincombea mirabilis*, n.g. et sp. (x 33).
For lettering see p. 260.

Type, Unnumbered specimen in Mr. Mitchell's Collection. Label:—"Wing, Newcastle Measures" (in ink); "Loc. Nr. Belmont" (in pencil).

Horizon.—Upper Permian of Belmont, N.S.W.

I think it very probable that Specimen No. 25, described briefly on pp. 740-741 of my previous paper, belongs to this species, though I have not had an opportunity of further studying the specimen.

It does not seem possible to say anything very definite about the affinities of the Permofulgoridae at present, owing to the poor preservation and incompleteness of the specimens so far discovered. It is clear that the venation of the forewing, with the exception of the clavus, is very feebly developed. This is a condition not infrequently met with in the Auchenorrhyncha, but it is usually associated with a considerable thickening of the membrane of the tegmen. The genus *Permofulgor*, however, does not seem to have had a thickened tegmen, and we must wait until a more perfect specimen is discovered before we shall be in a position to discuss its affinities with any certainty.

Division *STERNORRHYNCHA*.

Family PINCOMBEIDAE, n.fam.

Small insects with broad forewings having a long, narrow clavus ending about half-way along the posterior border, with two strong, sub-parallel anal veins. R, M and Cu_1 all arising not far from base from a single strong principal vein, at the same point.

Genus PINCOMBEA, n.g. (Plate xxxiv., fig. 4; Text-fig. 2).

Forewing with nearly straight costa, the apex almost in line with it. Sc a nearly straight, unbranched vein, running close to and just above R to end up on the costa about four-fifths from base. R_1 and Rs both unbranched, the former ending up just above, the latter a little below the apex; Rs arising just before half-way along the wing-length. M three-branched, M_{3+4} being unbranched and arising from M at about the middle of the wing, while M_{1+2} is forked dichotomically considerably further distad. Cu_1 a very strong vein running obliquely downwards across the basal half of the wing; before half-way, it forks strongly; the anterior branch, Cu_{1a}, arches outwards, and ends up on the posterior border well beyond end of clavus; the posterior branch, Cu_{1b}, continues the straight line of the basal portion of the vein, and ends up exceedingly close to Cu_2. Cu_2 a weakly formed, almost straight, furrow vein. 1A and 2A very strongly formed. Distal border of wing from R_1 to end of clavus wide and well rounded. Only two cross-veins present, viz. a short basal one (*sc-r*) connecting Sc with R, and a longer one (*r-m*) distally between Rs and M_1, at right angles to both. An apparent cross-vein joining Cu_1 and Cu_2 basally, and very weakly formed, is almost certainly the true basal piece of Cu_1 as marked in Text-fig. 2, in which case the strong stump of Cu_1 arising from the principal vein must be actually M_5, as in Paramecoptera.

Genotype, *Pincombea mirabilis*, n.sp.

The genus is dedicated to its discoverer, Mr. Torrington H. Pincombe, of New Lambton, near Newcastle, N.S.W., who has been assisting Mr. Mitchell in the exploration of the Belmont Beds.

PINCOMBEA MIRABILIS, n.sp. (Plate xxxiv., fig. 4; Text-fig. 2.)

Total length 3 mm.; *greatest breadth* 1.2 mm.

A perfect specimen of a forewing, and certainly the smallest Palaeozoic insect wing yet discovered. The impression is on the smooth surface of a pale grey cherty shale, and is remarkably clear. R_1, Cu_1 and the anal veins stand up as

strong ridges, Cu_2 and Sc lying in deep furrows. This shows that the impression is the obverse or cast of a right forewing. Unfortunately the reverse was lost, although a careful search was made for it.

Type, Specimen No. P. 2 in Mr. John Mitchell's Collection.

Horizon.—Upper Permian of Belmont, N.S.W.

At first sight, this wing appears to be nothing more than a slight smudge on the rock surface, and it is only with the aid of a lens of considerable power that the perfection of the venation can be made out.

This is the first Sternorrhynchous wing discovered at Belmont. The other known Sternorrhynchous wing from the Upper Permian Beds of New South Wales is *Lophioneura ustulata* Till., recently described from Merewether Beach, near Newcastle (These Proceedings, xlvi., pt. 4, 1921, p. 420), and therefore probably somewhat older in geologic time than the present species. A comparison of the two wings shows considerable differences, sufficient, in my opinion, to justify the formation of a separate family for each. In *Lophioneura*, the costal area is wide and short, Sc ending up well before half-way along the costa, R_1 ending up a little beyond half-way, and the whole shape of the wing being widely different from that of *Pincombea*. *Lophioneura* has Rs forked, M also only once forked, Cu_1 with a very weak distal fork, and the clavus very short, excessively narrow, and without any anal veins upon it; there are also no cross-veins. Both wings are very primitive, for Sternorrhynchous types, in having the veins M and Cu_1 arising from the principal vein so close to the base. But, whereas in *Lophioneura* the three veins Cu_1, M and Rs come off from the principal vein separately in order, from the base outwards, at short intervals, in *Pincombea* Cu_1 and M come off at the same point, with Rs arising much further distad from R_1.

The simple Rs and three-branched M of *Pincombea* can be paralleled in many present-day Aphiidae. This latter family could certainly be derived from the Pincombeidae by the fusion of Sc with R, together with very strong distal movement of all the veins coming off from the principal vein, general narrowing of the wing, and especially strong narrowing of the basal portion, leading to complete elimination of any distinct clavus and anal veins. These immense differences only show us how much older *Pincombea* is than any existing Sternorrhynchous type.

A more useful comparison may perhaps be made with the incomplete forewing which I have named *Triassopsylla plecioides*, from the Upper Triassic Wianamatta Shale Beds of Glenlee, N.S.W. (These Proceedings, xlii., pt. 4, 1917 (1918), p. 754). Though only the distal half of this wing is preserved, it agrees with *Pincombea* in having M forked in almost exactly the same way, in having Rs simple, and Sc running very close to R. It differs in having R_1 distally forked, the apical border of the wing more evenly rounded, and two cross-veins between R_1 and Rs, while the cross-vein between Rs and M, though present, is more basally placed than in *Pincombea*. *Triassopsylla plecioides* was placed by me, with some doubt, in the family Psyllidae. Until we know the venation of the basal half of the wing, that doubt must remain; but it is at any rate significant that the distal portions of the two wings show so much similarity.

In the perfection of the clavus, *Pincombea* is certainly the most generalised Sternorrhynchous type yet discovered, and in its general structure it stands closer to the Anchenorrhyncha than any other known type, and serves to bridge over partially the wide gap which now separates the two main divisions of the Homoptera.

Order **PROTOMECOPTERA.**

Family ARCHIPANORPIDAE.

ARCHIPANORPA (?) BAIRDAE, n.sp. (Plate xxxiii., fig. 1.)

A fragment of a very large wing. *Total length* 12 mm., *greatest breadth* 10 mm., representing portion of a complete wing probably 30 mm. long. The specimen is cracked obliquely across near the middle, but all the veins are only slightly displaced, and can be followed across the crack. The uppermost vein would appear to be Sc, followed in order by the unbranched R_1, the dichotomically branched Rs, of which eight branches are shown distally, the three-branched M, and finally by Cu_1, carrying a peculiar closed cell towards its distal end. The manner of branching of the veins, and the system of weak cross-vein struts here and there at irregular intervals, strongly suggests a close resemblance to the Upper Triassic Archipanorpidae; but there is scarcely enough of this large wing represented to enable it to be placed with any certainty. It might conceivably be a very ancient type of the Order Planipennia.

Type, Specimen No. P. 1 in Mr. Mitchell's Collection.

This species is dedicated to Mrs. Pincombe (née Baird) who discovered it at Belmont.

It is much to be regretted that this fine wing is not more completely preserved, so as to allow of a more certain determination of its affinities.

Order **PARAMECOPTERA.**

Family PARABELMONTIIDAE, n. fam.

Insects having the same general type of venation as *Belmontia* Till., but with the wings somewhat broader, more rounded apically, Rs and M having six branches each, and Cu_1 *without any distal forking.*

The discovery of this new type of wing necessitates a change in the definition of the Order Paramecoptera as originally given by me (These Proceedings, xliv., pt. 2, 1919, p. 234). The portions dealing with Rs, M and Cu should be altered to read as follows:—

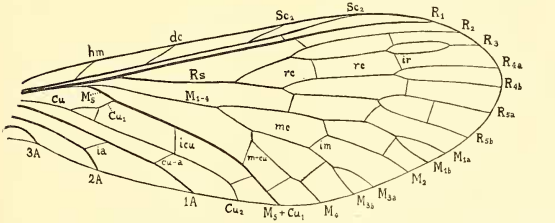
Rs dichotomically branched, with six or more separate branches on the wing-margin. M dichotomically branched, with five or more separate branches on the wing-margin. Cu_1 either simple, as in Mecoptera and Diptera, or having an apical fork, as in Megaloptera, Trichoptera and Lepidoptera; Cu_2 a weak, concave, simple vein.

It will be seen that, by this alteration, the differences between the Paramecoptera and true Mecoptera are considerably narrowed, one of the chief distinctions hitherto having been the presence of the apical fork of Cu_1 in the former Order. However, I think it wise to keep the Paramecoptera as a distinct Order, since it is clear that the general plan of their venation is not truly Mecopterous, but more of the type found in primitive Trichoptera, Lepidoptera and Diptera, though with more branches to both Rs and M. The Parabelmontiidae would seem to stand in much the same relationship to the Order Diptera as the Belmontiidae do to the Trichoptera and Lepidoptera. It is evident that, in these generalised types, we have come upon a point in the evolution of the Panorpoid Orders in which the venational differences which later led to the Trichopterous and Lepidopterous types on the one hand, and to the Dipterous type on the other (through the intermediate Order Paratrichoptera) are just beginning to form. If we had the full fossil record, it would be impossible to

set any arbitrary limits to the various Orders, for each type would merge by small degrees into the next. As matters stand, the chain of types already discovered is practically complete enough for us to indicate the courses of the various lines of evolution without any doubt; the more complete it may become, by discovery of new intermediate types, the more difficult it will be to uphold any one of these new fossil Orders as a separate entity. Yet we may not place these types within recent Orders, without leaving it to be inferred that we believe them to have belonged morphologically to such Orders in other characters besides the wing-venation. *Belmontia* and *Parabelmontia* were plainly, from their venation alone, not true Scorpion-flies, but more generalised insects, probably combining the more archaic characters of the true Mecoptera with those of the Megaloptera.

Genus PARABELMONTIA, n.g. (Plate xxxiii., fig. 2; Text-fig. 3.)

Forewing.—Costal space narrow, with humeral (*hm*) and distal (*dc*) veinlets present, and Se forked distally into Se_1 and Se_2. R_1 a strong, straight, unbranched vein, connected with Sc_2 distally by a short cross-vein, and with R_2 by another one, close to the former. Rs arising from R at about one-fifth of the wing-length, and dividing into R_{2+3} and R_{4+5} slightly before half-way. R_{2+3} divides into R_2 and R_3 at a level only slightly distad from that at which R_{4+5} divides; R_2 is simple, but R_3, though ending simply on the wing-margin, divides to form a small elongated cell, which is closed again not far from the margin, by fusion of the two branches. R_4 and R_5 both divide again about half-way along their lengths, and their branches run free to the margin, R_{4b} being at the apex of the wing. The radial cell (*re*) may be considered closed, much as in *Bel-*



Text-fig. 3. *Parabelmontia permiana*, n.g. et sp. (x 6). For lettering, see p.260.

montia, by the cross-vein placed distally between R_3 and R_{4+5}, and is also crossed, about its middle, by another cross-vein. M is fused basally with R, but leaves it below *hm*, and shortly afterwards divides into M_{1-4} and M_5, the latter being a very strongly formed convex vein forming the upper arm of a large cubito-median Y-vein closely resembling that of *Belmontia*; the lower arm, or basal piece of Cu_1, is broken near its middle at a point where a cross-vein descends from it on to Cu_2. M_{1-4} divides slightly before the level of the first dichotomy of Rs, and each branch again divides into two, of which the upper branch in

each case (M_1 and M_3) is again forked distally, while the lower (M_2 and M_4) remains simple, so that there are altogether six branches of M_{1-4} ending on the wing-margin. The median cell (*me*) is closed by a strong cross-vein, and both forks are sessile upon it. The main stem of the cubito-median Y-vein, $M_{3+4}+Cu_1$, is a strong convex vein resembling that of *Belmontia*, but *without any distal forking*; in its connections with M_4 and Cu_2, it strongly recalls the formation of Cu_1 in the Upper Triassic Paratrichoptera, such as *Aristopsyche*. Cu_2 is curved distally, as in *Belmontia*, and connected with the straight, strong 1A by a single cross-vein, *cu-a*. 2A is little more than half as long as 1A, is bent distally as in *Belmontia*, and is connected with 1A above the bend by a single cross-vein, *ia*. 3A is a short, much-curved vein, isolating, between itself and the border, a small convex jugal area.

Genotype, *Parabelmontia permiana*, n.sp.

Closely related to *Belmontia*, from which it differs chiefly in the unforked Cu_1, the different number of branches of Rs and M, the somewhat different arrangement of the cross-veins, and the different position of the forking of R_{4+5}, which, in *Belmontia*, is placed very close up to the primary forking of Rs.

The origin of the Trichoptera and Lepidoptera from forms resembling *Belmontia* has already been dealt with in a previous paper (*op. cit.* pp. 242-8). In the same work (pp. 248-250) I also discussed the affinities of *Belmontia* with the Paratrichoptera and Diptera, and concluded that there was no direct ancestral connection between them. In the case of *Parabelmontia*, we can say with certainty, owing to the formation of Cu_1, that this genus is *not* ancestral to the Trichoptera and Lepidoptera; but, for the same reason, it comes into the direct ancestral line of the Paratrichoptera and Diptera, in which the formation of Cu_1 is very closely similar. If we postulate the existence of other types, closely allied to *Parabelmontia*, but with the short costal vein still not fully reduced to a veinlet (*hm*), as seen, for instance, in the genus *Aristopsyche* of the Paratrichoptera, then we could say with certainty that, from such a type, this latter Order is derivable simply by reduction of the number of branches of Rs and M to four each; and it would follow that the Diptera were also to be derived from it by further reduction. Or we may regard *Aristopsyche* as an archaic side-branch, which preserved the separate short costal vein, long after the rest of the group had lost it, and may then derive those of the Paratrichoptera which have no costal vein direct from forms like *Parabelmontia*, and the whole of the Diptera from those more specialised Paratrichoptera themselves.

Parabelmontia permiana, n.sp. (Plate xxxiii., fig. 2; Text-fig. 3.)

An almost perfect forewing; *total length* 17 mm., *greatest breadth* 7 mm. The impression is the reverse or mould of the wing, as is proved by the fact that R_1, Cu_1 and 1A appear as deep furrows; as the apex lies to the right, the impression must be the cast of a left forewing. The wing lies upon the smooth surface of a grey cherty shale, the whole wing being pale ochreous in colour, and stained fulvous along the costa and posterior border of clavus. There are slight abrasions of the apex and tornus, and the course of the distal margin is very faint in consequence; otherwise the venation is practically perfect. The system of cross-veins, as will be seen from Text-fig. 3, is very like that of *Belmontia*. The closure of the small cell on R_3 may perhaps be considered a specific rather than a generic character.

Type, Specimen No. 54 in Mr. Mitchell's Collection.

Horizon.—Upper Permian of Belmont, N.S.W.

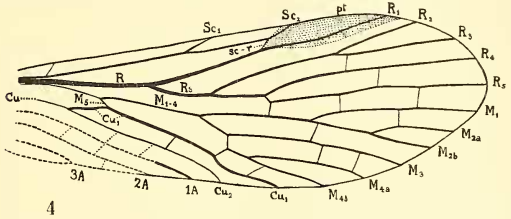
This is the first specimen of an insect wing found at Belmont stained an ochreous colour, and thus standing out clearly from the grey rock on which it is impressed.

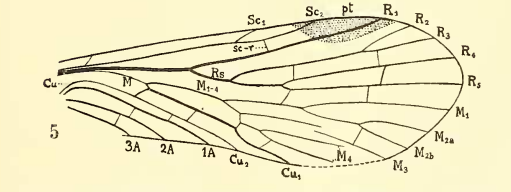
Order **MECOPTERA.**

Family PERMOCHORISTIDAE.

PERMOCHORISTA SINUATA, n.sp. (Plate xxxiv., figs. 5, 6; Text-fig. 4.)

Two specimens of forewings referable to this species are present in the Collection. Specimen No. 55 (Plate xxxiv., fig. 5) is a very clear impression, being both the obverse and reverse of a right forewing, the obverse with R and Cu1 standing up as high ridge-veins, and the apex being to the right. The wing is perfect except for the loss of most of the clavus or anal area. *Total length*





Text-fig.4. *Permochorista sinuata*, n.sp. (x 13.3). Dotted veins restored from the paratype, all the rest representing the holotype.

Text-fig. 5. *Permochorista affinis*, n.sp. (x 13.3).

For lettering, see p.260.

8 mm.; *greatest breadth* 3 mm. Specimen No. 51 (Plate xxxiv., fig. 6) is a slightly larger wing, obverse only, also on a medium grey cherty shale, but not so clearly impressed as No. 55. *Total length* 8.3 mm. It is not quite perfect, the extreme base being broken off, a considerable piece removed from the

pterostigmatic area, and a smaller piece from the border of the clavus. But it shows most of the three anal veins, which are absent from No. 55.

This species may be distinguished at once from *P. australica* Till. and *P. mitchelli* Till., already described from Belmont (*op. cit.*, pp. 733-6) by the very marked sinuous curvature of Cu1 distally, by the condition of Sc, which only gives off the humeral veinlet (*hm*) basally and then divides into Sc1 and Sc2 distally, without any additional veinlets being present, and by the peculiar condition of the basal piece of M_4, which is specialised to resemble a cross-vein. The positions of the forkings of the main veins are closely similar to those of *P. australica*, while the formation of the cubito-median Y-vein, completely revealed for the first time in this species, shows that the interpretation placed by me on the same partially preserved area in *P. mitchelli* was substantially correct. Of the two arms of the Y-vein, the upper, M_5, is much shorter and also not so strongly formed as the lower, Cu1; this may be profitably contrasted with the condition shown in *Parabelmontia* (Text-fig. 3). The system of cross-veins is very weakly developed, and much less numerous than in the previously described species.

Types, Holotype, Specimen No. 55, of which both the obverse and reverse impressions have been preserved; the obverse being in Mr. Mitchell's Collection, the reverse in the Collection of the Cawthron Institute, Nelson, N.Z. (presented to me by Mr. Mitchell). Paratype, Specimen No. 51, in Mr. Mitchell's Collection (obverse only).

In Text-fig. 4, the dotted anal veins are restored from Specimen No. 51, while the rest of the wing is drawn from Specimen No. 55.

PERMOCHORISTA AFFINIS, n.sp. (Plate xxxiv., fig. 6; Text-fig. 5.)

Total length 6.6 mm.; *greatest breadth* 2.5 mm. An almost perfect obverse of a right forewing on medium grey cherty shale, but with the end of the clavus slightly buckled and the veins above it broken.

Closely allied to *P. sinuata*, n.sp., from which it differs in the following points:—Size considerably smaller, wing somewhat broader towards apex, Sc with its two distal branches closer together, Sc1 arising half-way along the wing-length instead of well before it as in *P. sinuata*; *sc-r* placed closer to Sc1 and running in a different direction from what it does in *P. sinuata*; pterostigma much shorter and differently shaped; fork of R_{2+3} much shorter; cubito-anal Y-vein differently formed, with both upper and lower arms much shorter; cross-veins differently arranged, as may be seen by comparing Text-figs. 4 and 5.

Type, Specimen No. P. 3. in Mr. Mitchell's Collection. This specimen was discovered by Mr. T. H. Pinecombe.

It is possible that the differences between the two species here described, on the one hand, and those previously described by me, on the other, (viz. the formation of Sc and its veinlets, and the curvature of the distal end of Cu1), might justify the removal of the two new species to a new genus. As more material is sure to come to hand later on in this family, this question is best left over until the fullest information is available on the subject.

It might be suggested that *P. affinis* is only the hindwing of *P. sinuata*. I have decided against this; firstly, because the impression of *P. affinis* is a very clear one, strongly suggestive of a forewing; and secondly, because it has all three anal veins separate. All known Mecoptera have 1A partially fused with Cu2 in the hindwing; and it will be seen from my previous figure of *P. mitchelli*. (*op. cit.*, p. 735) that this fusion was almost certainly present in hindwings of the family Permochoristidae.

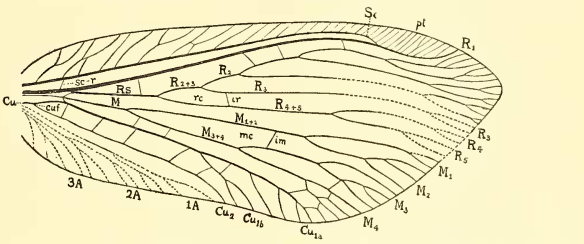
Order **PLANIPENNIA.**

Family PERMITHONIDAE, n. fam.

Rather small insects with the forewing fairly broad, the apex rather pointed. Sc fusing with R_1 distally. Rs pectinately branched, but with the original dichotomy of R_{4+5} preserved. Four cross-veins between R_1 and Rs. Radial cell (*rc*) present, closed by a crossvein (*ir*). M with its original dichotomie branching preserved, and the branches not crushed closely together as in recent Planipennia owing to increase in the number of branches of Rs. Median cell (*mc*) present, closed by a cross-vein (*im*). Fairly numerous additional distal forkings on the branches of Rs and M, including small terminal twiggings. Cubito-median Y-vein still preserved, the upper branch, M_3, very short in comparison with the lower, Cu_1. Primary cubital fork (*cuf*) very close to base. Cu_1 a fairly strong convex vein pectinately branched. Cu_2 a simple, weak, concave vein. (Anal veins not preserved).

Genus PERMITHONE, n.g. (Plate xxxiii., fig. 3; Text-fig. 6.)

Characters as for the family, with the following additions:—Costal area moderately broadened near base, the series of costal veinlets not closely crowded together, mostly simple, but a few forked or connected together by short cross-veins. Pterostigmatic veinlets much closer together. A single cross-vein, *sc-r*,



Text-fig. 6. *Permithone belmontensis*, n.g. et sp. (x 12). For lettering, see p.260. Wing restored by the removal of the overfold (missing veins shown by dotted lines) and placed with apex to the right.

connects Sc with R basally. Five pectinate branches to Rs. Radial cell rather short. Median cell very long; the fork of M_{1+2} stalked from the cell, that of M_{3+4} sessile upon it. Cu_{1a} with four short branches; Cu_{1b} distally forked. Two medio-cubital cross-veins situated before half-way. A series of inter-cubital cross-veins present.

Genotype, *Permithone belmontensis*, n.sp.

This is the first true Lacewing to be discovered in Palaeozoic strata, and is noteworthy in being in some respects even more archaic than the hypothetical Archetype which I postulated for this Order in my previous work on the Panorpoid Complex (These Proceedings, xliv., pt. 3, 1919, p. 699). Apart from the

distal fusion of Sc with R_1, which, though apparently a specialisation, may be due, as in the Perlaria, to a partial fusion only of Sc_2 with R_1, and may therefore be the original condition in the Planipennia, the wing before us is an absolutely generalised Planipennian, with primitive terminal twigging of the veins, primitive pectination of R_2+_3, an absolutely primitive condition of M, primitive pectination of Cu_1, and even two characters which one could scarcely have suspected ever to have been present within the Order, viz. the closure of the radial and median cells by special cross-veins. The wing also stands very close to the Archetype of the Megaloptera, but the terminal twigging places it definitely within the Planipennia, as also does the position of the primary cubital fork very close to the base of the wing. It is to be distinguished from the more densely veined Corydalid types, of which *Protohermes davidi* Weele (*op. cit.*, p. 696) is a good example, by the much smaller number of costal veinlets and interradial cross-veins, as well as by the much more basal position of the primary cubital fork. It is, however, possible to derive the whole of the Megaloptera as well as the whole of the Planipennia from this wing-type, provided we assume that the Megaloptera are an aquatic offshoot from the very base of the terrestrial Planipennia, and that the Corydalidae are an older type than the Sialidae. These assumptions are, however, scarcely justified, and it seems more logical to assume that definite Megalopterous types were in existence in the Upper Permian, though not necessarily in Australia, and that the present fossil is a true Planipennian, from which the Mesozoic Prohemerobiidae, and consequently the whole Order as we know it at present, are easily derivable by further specialisations. The relationship of the present-day Ithonidae of Australia to the fossil type is so evident that I have selected a generic name for the fossil to indicate it as the Permian ancestor of that family; but it is scarcely less easy to derive from it such families as the Psychopsidae, Berothidae and Hemerobiidae, not to mention the Dilaridae, which do not occur in Australia.

PERMITHONE BELMONTENSIS, n.sp. (Plate xxxiii., fig. 3; Text-fig. 6.)

The specimen is the obverse or cast of a left forewing, showing R_1 as a strongly formed convex vein, Cu_1 as a slightly less strong, similar vein. The impression is on cherty shale stained with iron (ochreous), the wing itself being of an ochreous colour, shading to fulvous along the distal portion of the posterior margin, from half-way up to apex. The anal area is missing, and there is a slight overfold of the membrane a little below the apex. This appears to have been brought about by a tearing of the wing from near the end of M_1 across R_4+_5, followed by a slight buckling of the apical portion, so that the lower side of the tear came to overlap the upper slightly. In Text-fig. 6, I have restored the wing, adding the missing veins covered up by the overlapping, and turning the apex to the right. *Total length* 9.4 mm.; *greatest breadth* 4 mm.

It should be noted that the terminal furrows so characteristic of the Order Planipennia, situated between the terminal twigs of the main veins, are clearly to be seen in this fossil around and above the apex, as are also the swollen bases of the tufts of hairs situated along the wing-margin between the twigs.

Type, Specimen No. 52, in Mr. Mitchell's Collection. Label "New Insect Wing, Belmont, N.S.W., Coll. Mitchell."

Mr. Mitchell is heartily to be congratulated on this wonderful find, which brings the record of the Lacewings right back from the Upper Triassic of Ipswich to the Upper Permian. We may express the hope that other representatives of the Order may yet be found at Belmont.

In concluding this paper, we may briefly review the position of the Panorpoid Orders as revealed to us in Upper Permian times by these fossils. At the present day, the six main Orders fall into three groups of two each, viz.

(*a*) Mecoptera and Diptera, characterised by simple Cu_1 and dichotomic branching of Rs.

(*b*) Trichoptera and Lepidoptera, characterised by forked Cu_1 and dichotomic branching of Rs.

(*c*) Megaloptera and Planipennia, characterised by forked Cu_1 and pectinate branching of Rs.

Each of these groups is now seen to have been represented by Upper Permian ancestors in Australia,

(*a*) by true Mecoptera of the family Permochoristidae, and by the genus *Parabelmontia* of the Paramecoptera.

(*b*) by the genus *Belmontia* of the Paramecoptera.

(*c*) by the genus *Permithone* of the Planipennia.

We are able, from this, to see that two Orders, the Mecoptera and Planipennia, were already in existence in Australia in Upper Permian times. On morphological grounds, we may also postulate the existence of true Megaloptera somewhere in the world at the same period, though not necessarily in Australia.

The history of the three more specialised Orders is now fairly plain. The type represented by *Parabelmontia* gave origin, in the Triassic period, to the main mass of the Paratrichoptera, from which the Diptera arose directly by reduction of the hindwing. The type represented by *Belmontia* gave origin, probably also in the Trias, to the common Trichoptero-Lepidopterous stem (almost certainly far outside Australia), and the two Orders became differentiated either in the Upper Trias or Lower Lias, the Lepidoptera remaining as an obscure group of Homoneurous types until the rise of the Flowering Plants in the Cretaceous brought with it the great development of the Heteroneura.

If the whole of the Insecta Holometabola had a common origin, as I believe to be the case, then it follows that both the Coleoptera and the Hymenoptera must have been represented by primitive types in the Upper Permian, or even earlier; since both these Orders are, morphologically, older in some respects than the Panorpoid Orders. Consequently we should expect to find, though not necessarily in Australia, primitive fossil beetles, allied probably to the Cupedidae, and primitive fossil Tenthredinoid Hymenoptera, somewhere in the higher Palaeozoic strata, in some part of the world.

Cawthron Institute, 20.2.22.

EXPLANATION OF PLATES XXXIII.-XXXIV.

Plate xxxiii.

Fig. 1. *Archipanorpa (?) bairdae*, n.sp. (x 7).
Fig. 2. *Parabelmontia permiana*, n.g. et sp. (x 5.8).
Fig. 3. *Permithone belmontensis*, n.g. et sp. (x 11.5).

Plate xxxiv.

Fig. 4. *Pincombea mirabilis*, n.g. et sp. (x 15.6).
Fig. 5. *Permochorista sinuata*, n.sp. Holotype obverse. (x 11.5).
Fig. 6. *Permochorista sinuata*, n.sp. Paratype. (x 11.5).
Fig. 7. *Permochorista affinis*, n.sp. (x 11.5).

Lettering of Text-figures.

1A, 2A, 3A, the three anal veins. Cu, cubitus; Cu_1, its anterior branch, dividing into Cu_{1a} and Cu_{1b}; Cu_2, its posterior branch, the vena dividens. *cu-a*, cubito-anal cross-vein. *cuf.*, primary cubital fork. *dc*, distal costal veinlet; *hm*, humeral veinlet. *ia*, inter-anal cross-vein. *icu*, inter-cubital cross-vein. *im*, inter-median cross-vein. *ir*, inter-radial cross-vein. M, media, dividing into M_{1-4} above and M_5 below, the latter forming the upper arm of the cubito-median Y-vein; M_1, M_2, M_3, M_4, branches of the media. $M_{3+4}Cu_1$, main stem of the cubito-median Y-vein, usually denoted as Cu_1. *mc*, median cell. *pt*, pterostigma. R, radius; R_1, its anterior branch or main stem; Rs, radial sector; R_2, R_3, R_4, R_5, its branches. *r-m*, radio-median cross-vein. *rc*, radial or discoidal cell. Sc, subcosta; Sc_1, Sc_2, its distal branches. *sc-r*, subcosto-radial cross-vein.